

C E R T I F I C A T E

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[Number of Prepaid Ledger] 040051

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[Document]	Specification	1
[Document]	Drawing	1
[Document]	Summary	1
[General Power of Attorney Number]		9801419
[Need of Proof]	Yes	

[Name of Document]

SPECIFICATION

[Title of the Invention]

Method for Producing Electrical Device

[CLAIMS]

[Claim 1] A method for producing an electrical device made up by a first object for bonding including a first electrode and a second object for bonding including a second electrode to be connected to said first electrode, by bonding said first object for bonding and said second object for bonding to each other, comprising the steps of

arranging an adhesive, containing a thermosetting resin and a first curing agent, at least on said first electrode, to form an adhesive layer;

arranging a second curing agent, reacted with said first curing agent by heating to polymerize said thermosetting resin, at least on said second electrode, to form a layer of the second curing agent;

positioning said first and second electrodes in register with each other; tightly contacting said adhesive on said first object for bonding with said second curing agent on said second object for bonding; and

thrusting said first and second objects for bonding against each other for interconnecting said first and second electrodes and allowing said thermosetting resin to be polymerized by heating.

[Claim 2] The method for producing an electrical device according to claim 1 wherein electrically conductive particles are added to said adhesive from the outset

and wherein said first and second electrodes are interconnected via said electrically conductive particles.

[Claim 3] The method for producing an electrical device according to claim 1 or 2 wherein one of said first and second curing agents is mainly composed of a silane coupling agent and the other is mainly composed of one or both of a metal chelate and a metal alcoholate.

[Claim 4] The method for producing an electrical device according to claim 3 wherein said metal chelate is an aluminum chelate.

[Claim 5] The method for producing an electrical device according to claim 3 wherein said metal alcoholate is an aluminum alcoholate.

[Claim 6] The method for producing an electrical device according to any one of claim 1 to 5 wherein said thermosetting resin is an epoxy resin.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

This invention relates to an adhesive, specifically relates to adhesives to interconnecting such as a semiconductor or a TCP to a substrate by thermo-compression.

[0002]

[Prior Art]

Conventionally, a thermally curing adhesive, containing an epoxy resin as a

thermosetting resin, and which is cured on thermal polymerization of the epoxy resin, is used as an adhesive used for bonding objects for bonding, such as a semiconductor or a substrate, to prepare an electrical device.

[0003]

For accelerating the reaction of thermal polymerization of the epoxy resin, a curing agent is routinely used in an adhesive. As this sort of the curing agent, a curing agent, functioning as a polymerization catalyst for the epoxy resin, such as an imidazole compound, or a curing agent, which per se undergoes an addition reaction with an epoxy resin to form a polymer, such as a mercaptan compound or an amine compound, is widely used.

In case the imidazole compound is used as a curing agent, the adhesive may be cured in a short time. However, in this case, the adhesive needs to be heated to an elevated temperature such that the objects for bonding may be subjected to deformation, such as elongation or bend, due to heating.

[0004]

In case the amine compound or the mercaptan compound is used as a curing agent, the adhesive may be cured at a lower temperature. However, in this case, the time needed for the adhesive to be cured is longer than with the imidazole compound, thus lowering the productivity. With the adhesive, cured at a lower temperature, the polymerization reaction proceeds even at an ambient temperature, and hence the adhesive is appreciably inferior in shelf life. It has so far been

difficult to obtain an adhesive cured at a lower temperature in a shorter time and which nevertheless has a long shelf life.

[0005]

[Problems to be Solved by the Invention]

It is an object of the present invention to provide an adhesive which is possible to resolve the problem inherent in the aforementioned conventional method with having a long shelf life and which may be cured at a lower temperature in a shorter time.

[0006]

[Means to Solve the Problem]

For accomplishing the above objects, the invention claimed in claim 1 provides a method for producing an electrical device made up by a first object for bonding including a first electrode and a second object for bonding including a second electrode to be connected to the first electrode, by bonding the first object for bonding and the second object for bonding to each other. The method of the invention of claim 1 comprises the steps of arranging an adhesive, containing a thermosetting resin and a first curing agent, at least on the first electrode, to form an adhesive layer, arranging a second curing agent, reacted with the first curing agent by heating to polymerize the thermosetting resin, at least on the second electrode, to form a layer of the second curing agent, positioning the first and second electrodes in register with each other, tightly contacting the adhesive on the

first object for bonding with the second curing agent on the second object for bonding, and thrusting the first and second objects for bonding against each other for interconnecting the first and second electrodes and allowing the thermosetting resin to be polymerized by heating.

The invention of claim 2 is the method for producing the electrical device according to claim 1, electrically conductive particles are added to the adhesive from the outset and the first and second electrodes are interconnected via the electrically conductive particles.

The invention of claim 3 is the method for producing the electrical device according to claim 1 or claim 2, one of the first and second curing agents is mainly composed of a silane coupling agent and the other is mainly composed of one or both of a metal chelate and a metal alcoholate.

The invention of claim 4 is the method for producing the electrical device according to claim 3, the metal chelate is an aluminum chelate.

The invention of claim 5 is the method for producing the electrical device according to claim 3, the metal alcoholate is an aluminum alcoholate.

The invention of claim 6 is the method for producing the electrical device according to any one of claim 1 to 5, the thermosetting resin is an epoxy resin.

[0007]

The present invention is configured as above. If the second curing layer on the second object for bonding is thrust against the adhesive layer of the first object

for bonding, the first curing agent in the adhesive layer is commingled with the second curing agent forming the second curing layer. If, in a state the first and second curing agents are commingled with each other, the adhesive layer is heated, the first and second curing agents react with each other to allow polymerization of the thermosetting resin.

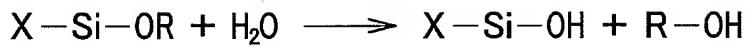
[0008]

If, in case the adhesive is high in viscosity or the adhesive is in the form of a film, the second object for bonding is thrust as the adhesive is heated, the adhesive is softened by the heating, thus assuring facilitated intrusion of the second electrode and the second curing agent into the bulk of the adhesive, as well as facilitated diffusion of the second curing agent into the adhesive layer. The second curing agent may be diffused into the adhesive layer more readily by employing the second curing agent, liquid at ambient temperature.

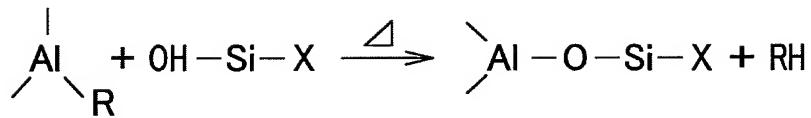
The reaction in which the silane coupling agent and the metal chelate (or the metal alcoholate) are used as the first and second curing agents respectively is expressed by the following reaction formulas (1) to (4):

[0009]

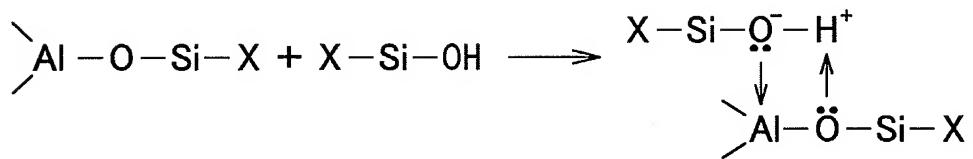
[Chemical Formula 1]



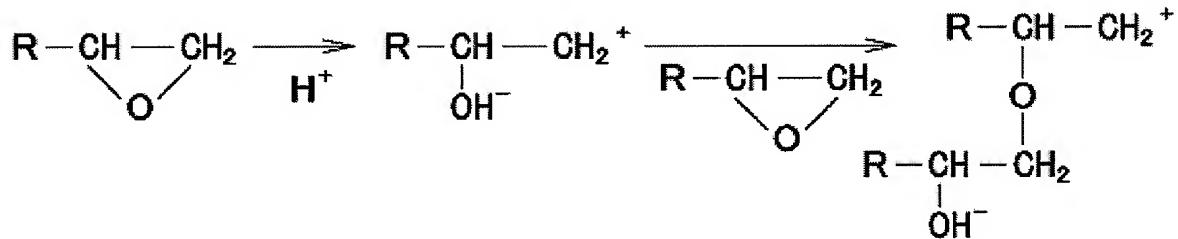
... reaction formula (1)



... reaction formula (2)



... reaction formula (3)



... reaction formula (4)

[0010]

The silane coupling agent, indicated on the left side of the reaction formula (1), has an alkoxy group (RO) linked to silicon. If the silane coupling agent is contacted with water contained in atmosphere or in an adhesive, the alkoxy group is hydrolyzed to yield silanol.

An aluminum chelate, as a metal chelate, is indicated on the left side of the reaction formula (2), by way of an example. If, as the second curing agent and the adhesive are mixed together, the adhesive is heated, the silanol, yielded on hydrolysis of the silane coupling agent, is reacted with the aluminum chelate, due to heating, so that silicon of the silanol is linked to aluminum through an oxygen atom (right side of the reaction formula (2)).

[0011]

If another silanol is coordinated to the aluminum chelate in this state by an equilibrium reaction, a Bronsted acid point is produced, as indicated on the right side of the reaction formula (3), to yield an activated proton.

As indicated by the reaction formula (4), the epoxy ring, disposed at a terminal end of the epoxy resin, is opened by an activated proton and polymerized with an epoxy ring of another epoxy resin (cationic polymerization).

[0012]

Since the reaction by the reaction formulas (2) and (3) proceeds at a temperature lower than the curing temperature of a conventional adhesive (180°C or higher), the two-component adhesive according to the present invention is cured

at a lower temperature in a shorter time than with a conventional adhesive.

Since the reaction of the cationic polymerization proceeds as a chain reaction, the adhesive layer in its entirety may be cured even in case the second curing agent is not evenly dispersed into the adhesive layer.

[0013]

If, in case the silane coupling agent is used as the first and second curing agents, water is added to these first and second curing agents, the reaction of the reaction formula (1) may proceed in the curing agent, thus accelerating the reaction in curing the adhesive.

As a method for arranging the layer of the second curing agent, the layer of the second curing agent may readily be formed, from the perspective of the manufacturing process, by charging the second curing agent into a vessel, holding the second object for bonding by a holding mechanism, and by immersing the second object for bonding in the second curing agent in the vessel.

[0014]

The method for forming the layer of the second curing agent is not limited to the above method. For example, there are such a method consisting in spraying the second curing agent to the area of the second object for bonding to be bonded to the first object for bonding, and such a method consisting in coating the second curing agent using e.g. a brush. With the use of these methods, the amount of consumption of the second curing agent may be smaller than with the method of immersing the

object for bonding in the second curing agent.

In case the second curing agent, solid at room temperature, is used, it may be used as a coating solution, obtained by dispersing the agent in e.g. an organic solution, in which case the second curing layer may be formed more readily.

[0015]

[Preferred Embodiment of the Invention]

A method for producing an electrical device according to the present invention is explained in detail.

For producing a paste-like adhesive, an epoxy resin as a thermosetting resin, a silane coupling agent as a first curing agent, and electrically conductive particles, are mixed and agitated together. This adhesive has not been added by metal chelates nor by metal alcoholates and has been added solely by a silane coupling agent. Hence, there is produced no polymerization reaction of the epoxy resin, so that the adhesive is not cured.

[0016]

Numeral 21 of Fig. 1(a) shows a release film. The paste-like adhesive is coated in a preset amount on the release film 21, subsequently be dried to form an adhesive layer 25 on the surface of the release film 21(Fig. 1(b)).

Numeral 27 of Fig. 1(b) shows dispersed electrically conductive particles mixed into the adhesive layer 25.

[0017]

Numeral 11 of Fig. 2(a) shows an LCD (liquid crystal display), a first object for bonding. The LCD 11 includes a glass substrate 12 and a plural number of first electrodes 13 which formed on one surface of the glass substrate 12. Here, four first electrodes 13 are shown.

[0018]

The adhesive layer 25 on the release film 21 as shown in Fig. 1(b) is thrust against the surface of the LCD 11, carrying the first electrodes 13 of the LCD 11, and to which the TCP as later explained is to be connected (Fig. 2(b)). Since the force of bonding between the release film 21 and the adhesive layer 25 is smaller than the force of bonding between the adhesive layer 25 and the first electrodes 13, solely the release film 21 may be peeled off, as the film-like adhesive layer 25 is left on the LCD 11 (Fig. 2(c)).

[0019]

Numeral 15 of Fig. 3(a) shows a TCP (tape carrier package), a second object for bonding. The TCP 15 has a base film 16, on one surface of the base film 16 includes second electrodes 17.

On the surface of the TCP 15, carrying the second electrodes 17, a second curing agent is applied to form a layer of a second curing agent. Numeral 28 of Fig. 3(b) shows the layer of the second curing agent, and the second electrodes 17 are covered up by the layer of the second curing agent 28.

[0020]

The LCD 11 and the TCP 15 are arranged parallel to each other, with the surfaces of the LCD 11 and the TCP 15, carrying the first electrodes 13 and the second electrodes 17, respectively, facing each other. After that, move the LCD 11 and the TCP 15 relatively and the LCD 11 and the TCP 15 are positioned with the first electrodes 13 and the second electrodes 17 face each other, as shown in Fig.3(c) (positioning).

[0021]

The layer of the second curing agent 28 on the TCP 15 is then thrust against the adhesive layer 25 on the LCD 11 and the surface of the layer of the second curing agent 28 is brought into tight contact with the surface of the adhesive layer 25 (Fig.3(d)).

If the LCD 11 and the TCP 15 in their entirety are heated, as the TCP 15 is thrust against the LCD 11, the adhesive layer 25 is softened by the heat and the second electrodes 17 with the layer of the second curing agent 28 are intruded into the bulk of the adhesive layer 25 by the thrusting.

[0022]

Since the softened adhesive layer 25 is fluid, the second curing agent making up the layer of the second curing agent 28 is diffused into the adhesive layer 25, when the layer of the second curing agent 28 is intruded into the adhesive layer 25, so that the second curing agent is commingled with the first curing agent in the adhesive layer.

If the thrusting is continued and the second electrodes 17 are further intruded into the bulk of the adhesive layer 25, such that the electrically conductive particles 27 in the adhesive layer 25 are clinched between the second electrodes 17 and the first electrodes 13.

[0023]

If the thrusting under heating is further continued, the first curing agent and the second curing agent are reacted by heating to polymerize the epoxy resin to cure the adhesive layer 25 as the electrically conductive particles 27 are clinched between the first electrodes 13 and the second electrodes 17.

Numeral 10 of Fig. 3(e) shows the electrical device which is in a state which the TCP 15 and the LCD 11 bonded by the cured adhesive layer 25. In the electrical device 10, the LCD 11 and the TCP 15, bonded together by a cured adhesive layer 29, electrically interconnect the first and second electrodes 13, 17 via electrically conductive particles 27, while also mechanically interconnecting the electrodes.

[0024]

The foregoing explanation refers to a case where using the adhesive film. The present invention is, however, not limited to this case, by way of an example, the paste-like adhesive may be used.

Numeral 11 of Fig. 4(a) shows an equivalent LCD of shown in Fig. 2(a). That is, in case the paste-like adhesive is directly applied on the surface of the LCD 11, carrying the first electrodes 13, so as to overlie the first electrodes 13 to form an

adhesive layer comprised of paste-like adhesive. Numeral 75 of Fig. 4(b) shows the adhesive layer.

[0025]

If using the LCD 11 wherein the adhesive layer 75 was formed on its surface, and the TCP 15 shown in Fig. 3(b) for the thrusting under heating through the process shown in Figs. 3(c) to (e), the TCP 15 and the LCD 11 are bond together by the cured adhesive layer 79 to form an electrical device 70(Fig. 4(c)).

[0026]

[Example]

A paste-like adhesive was prepared by mixing 5 parts by weight of an epoxy silane coupling agent (manufactured by SHIN-ETSU KAGAKU KOGYO KK under a trade name of 'KBM-403'), as a first curing agent, 40 parts by weight of alicyclic epoxy resin celoxide (manufactured and sold by DICEL KAGAKU KOGYO KK under the trade name of '2021P') as an epoxy resin, 60 parts by weight of bisphenol A epoxy resin as an epoxy resin (manufactured and sold by YUKA SHELL EPOXY KK under the trade name of 'EP1009') and 10 parts by weight of electrically conductive particles. This adhesive was coated to a film thickness of 20 μm on the surface of the release film 21 to form the adhesive layer 25 by the process shown in Figs. 1(a) and (b).

[0027]

As the second curing agent, ethyl acetoacetate aluminum diisopropylate

(manufactured by KAWAKEN FINECHEMICAL KK under the trade name of 'ALCH'), as a metal chelate, was prepared. The TCP 15 and the LCD 11 were bonded together by the adhesive layer 25 and the second curing agent, with the process of Figs. 2(a), 2(a) to (c) and 3(a) to (e) to produce the electrical device 10 of the Example 1.

[0028]

As the TCP 15, such a one in which the second electrodes 17, each of a width of 25 μ m, were formed on the surface of the base film 16, at an interval of 25 μ m, was used. As the LCD 11, such a one carrying ITO (indium tin oxide) electrodes 13, each being of a sheet resistance of 10 Ω per 1 cm² surface area, was used. In bonding the LCD 11 and the TCP 15 to each other, a thermo-compression head maintained at 120°C was thrust against the areas of the LCD 11 and the TCP 15, superposed one on the other, for ten seconds, under heating, in order to raise the temperature of the adhesive layer 25 to 120°C. The 'peel-off strength test' was carried out for the electrical device 10 obtained by the above Example 1.

[0029]

[Peel-off Strength Test]

Using a tensile tester, the TCP 15, bonded to the LCD 11 to form the electrical device 10 was pulled in a direction of 90° relative to the surface of the LCD 11, at a rate of tension of 50 mm per min, and measurement was made of the peel-off strength when the TCP 15 is actually peeled off from the LCD 11(N/cm).

The measured results of the peel-off strength test of the Example are shown in the following Table 1.

[0030]

[Table 1]

Table 1: Results of Peel-off Strength Test

	Ex.1	Ex.2	Ex.3	Ex.4	Comp. Ex.1	Comp. Ex.2
peel-off strength (N/cm)	11.5	11.8	13.2	13.4	1.3	1.3

[0031]

<Example 2>

In the Example 2, the adhesive layer 25 was prepared in the same way as in Example 1, except using the metal chelate, used in Example 1, in place of the epoxy silane coupling agent, as the first curing agent.

Moreover, the epoxy silane coupling agent, used in Example 1, was provided as the second curing agent, in place of the metal chelate, and using the second curing agent and the adhesive layer to give the electrical device 10 of Example 2 through a process similar to the process of the above Example 1. The peel-off strength test in the same condition of Example 1 was carried out for the electrical device 10 obtained by the above Example 2. The result is shown in above Table 1.

[0032]

<Example 3, 4>

For producing the adhesive, 50 parts by weight of a product (manufactured and sold by DICEL KAGAKU KOGYO KK under the trade name of celoxide '2021P') as an epoxy resin, and 50 parts by weight of a product (manufactured and sold by YUKA SHELL EPOXY KK under the trade name of 'EP1001') as an epoxy resin, were mixed together. The resulting mixture was stirred, as it was kept at 70°C, to form a solution of paste-like epoxy resin. To 100 parts by weight of this solution of paste-like epoxy resin, 5 parts by weight of the first curing agent (epoxy silane coupling agent) used in Example 1 and 10 parts by weight of the electrically conductive particles, used in Example 1, were added and mixed together to form a paste-like adhesive. The adhesive, thus prepared, is coated on the surface of the LCD 11 of Example 1 to form an adhesive layer 75.

[0033]

The layer of the second curing agent 28 is formed, using the same second curing agent (metal chelate) as that used in Example 1, on the surface of the TCP 15 and bonding this TCP 15 to the LCD 11 carrying the adhesive layer 75 through the same process of the Example 1 to give the electrical device 70 of Example 3.

In the Example 4, the electrical device 70 was prepared under the same conditions as in Example 3, except using the second curing agent (metal chelate), used in the above Example 3, as the first curing agent, and also except using the first curing agent (epoxy silane coupling agent) used in Example 3, as the second curing agent.

[0034]

The 'peel-off strength test' in the same condition of Example 1 was carried out for the electrical device 70 obtained by the above Examples 3 and 4 and the results are shown in above Table 1.

<Comparative Example 1, 2>

In Comparative Example, 2 parts by weight of the second curing agent, used in Example 1, were added to and mixed with 115 parts by weight of the adhesive film used in Example 1, to prepare an adhesive containing both the first and second curing agents, and this adhesive was used to form adhesive layer under the same condition of Example 1. In this manner, the adhesive film having the adhesive layer was prepared on the surface of the LCD. The LCD carrying the adhesive layer, and the TCP prior to being coated with the second curing agent, were bonded together by the same process and conditions as those of the above Example 1 to produce the electrical device of the Comparative Example 1.

[0035]

In the Comparative Example 2, 2 parts by weight of the second curing agent, used in Example 3 (metal chelate), were added to and mixed with the paste-like adhesive used in the above Example 3, to produce an adhesive containing both the first and second curing agents, and this adhesive was applied to the surface of the LCD to form an adhesive layer. The LCD carrying the adhesive layer, and the TCP prior to being coated with the second curing agent, were bonded together to

produce the electrical device of the Comparative Example 2. The 'peel-off strength test' in the same condition of Example 1 was carried out for the electrical device obtained by the above Comparative Examples 1 and 2 and the results are shown in above Table 1.

[0036]

It is seen from the results of Table 1 that, with the Examples 1 to 4 in which the adhesive material having the first curing agent, and the second curing agent are discretely coated to the TCP 15 and to the LCD 11, the peel-off strength is higher, thus testifying to the high bonding strength of the adhesive of the present invention, despite the fact that the adhesive could be cured under the condition of the lower temperature and shorter time (120°C and 10 seconds) than conventionally. From these results, it is sure that the peel-off strength of the cured adhesive becomes higher when the silane coupling agent and the metal chelate are located on the different object for bonding respectively, despite the status of the adhesive(film-like or paste-like) or the combination of the first and the second curing agent.

[0037]

On the other hand, with the Comparative Examples 1 and 2, in which the first and second curing agents are added to the same adhesive, the peel-off strength was intolerably low. This is presumably ascribable to the fact that the viscosity of the adhesive was gradually increased by the reaction of the first and second curing

agents, as from the time of adhesive preparation, such that the adhesive lost its bonding properties before thrusting the TCP and the LCD to each other under heating.

[0038]

The foregoing explanation refers to a case where the first electrodes 13 and the second electrodes 17 are interconnected through the electrically conductive particles 27. The present invention is, however, not limited to this case. For example, it is possible to prepare the adhesive without the electrically conductive particles and to interconnect the first and second electrodes by directly abutting the second electrodes against the first electrodes during the thrusting under heating.

[0039]

The metal chelates or alcoholates that may be used may include a variety of center atoms, such as atoms of zirconium, titanium or aluminum. Of these, aluminum chelates (or aluminum alcoholates), having aluminum, exhibiting particularly high reactivity, as the center atoms, are preferred.

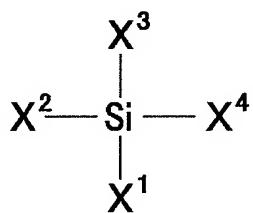
[0040]

There is no limitation to the sort of the ligands of the aluminum chelate or to the sort of the alkoxy groups of the aluminum alcoholates. For example, alkyl acetoacetate aluminum diisopropylate or aluminum monoacetyl acetonate bis(ethylacetoacetate), may be used as the aluminum chelate, in addition to ethyl acetoacetate aluminum diisopropylate used in the aforementioned Examples 1 to 4.

As the silane coupling agent, a compound shown by the following general formula (5) is preferably employed.

[0041]

[Chemical Formula 2]



... general formula (5)

[0042]

Of the substituents X^1 to X^4 in the general formula (5), at least one substituent is an alkoxy group. At least one of the substituents X^1 to X^4 other than the alkoxy group preferably includes an epoxy ring or a vinyl group. As the substituent having the epoxy ring, a glycidyl group is most preferred.

[0043]

The foregoing explanation refers to a case where the epoxy resin is used as the thermosetting resin added to the adhesive. The present invention is, however, not limited to this case. Although a wide variety of resins, such as urea resin, melaminic resin, phenolic resin, vinylether resin or oxycetane resin, that allow for cationic polymerization, may be used, it is preferred to use epoxy resin from the

perspective of the strength of the cured adhesive.

[0044]

The adhesive may be added by e.g. thermoplastic resin, in addition to the thermosetting resin. As the thermoplastic resin, phenoxy resin, polyester resin, polyurethane resin, polyvinyl acetal, ethylene vinylacetate or rubbers, such as polybutadiene rubber, may be used. Additionally, the adhesive of the present invention may be added by a variety of additives, such as ageing-proofing agents, fillers or colorants.

[0045]

The foregoing explanation refers to a case where the LCD 11 and the TCP 15 are used as the first object for bonding and as the second object for bonding. The present invention is, however, not limited to this embodiment. For example, the TCP 15 and the LCD 11 may be used as the first object for bonding and as the second object for bonding, respectively, and the adhesive and the layer of the second curing agent may be arranged on the TCP 15 and on the LCD 11, respectively.

The first and second objects for bonding are not limited to the LCD 11 or the TCP 15, such that the adhesive of the present invention may be used for interconnecting a wide variety of circuit substrates, such as semiconductor chip or flexible circuit board.

[0046]

[Effect of the invention]

The adhesive according to the present invention may be cured at a lower temperature in a shorter time than was possible up to now because the epoxy resin undergoes cationic polymerization by the reaction between the silane coupling agent and the metal chelate. The second curing agent is isolated from the first curing agent or from the thermosetting resin, no polymerization reaction of the thermosetting resin occurs before actually bonding the objects for bonding, thus improving the shelf life of the adhesive.

[Brief Description of the Drawings]

Fig. 1(a) and (b) shows an example of the process to produce an adhesive layer used in the present invention.

Fig. 2(a) to (c) illustrates the first half of the process to produce an electrical device.

Fig. 3(a) to (e) illustrates the latter half of the process to produce an electrical device.

Fig. 4(a) to (c) illustrates another example of the process to produce an electrical device.

[Explanation of Referenced Numerals]

10 and 70 electrical device, 11 first object for bonding (LCD), 13 first electrodes, 15 second object for bonding (TCP), 17 second electrodes, 25 and 75 adhesive layer, 27 electrically conductive particles, 28 layer of the second curing agent

[Name of Document] ABSTRACT

[Summary]

[Assignment] Obtaining an adhesive having a long shelf life and be cured at a lower temperature in a shorter time.

[Means to Solve]

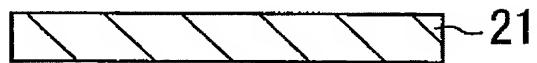
In accordance with the present invention, the adhesive has the first curing agent and thermosetting resin, but does not have the second curing agent. Because of this reason, the polymerization reaction of the thermosetting resin is not yield, and shelf life becomes long. When An adhesive layer 25 comprised of an adhesive agent and a layer of a second curing agent 28 comprised of a second curing agent are brought into tight contact with each other and thrust in this state to each other under heating, a first curing agent in the adhesive layer 25 and a second curing agent forming the layer of the second curing agent 28 react with each other so that the thermosetting resin in the adhesive layer is polymerized. In case a metal chelate or a metal alcoholate and a silane coupling agent are used as the first and second curing agents, respectively, the silane coupling agent and the metal chelate react with each other to yield cations and, by these cations, the thermosetting resin undergoes cationic polymerization. Therefore, the adhesive may be cured in a shorter time at a lower temperature than the conventional adhesive.

[Selected Drawing] FIG. 3

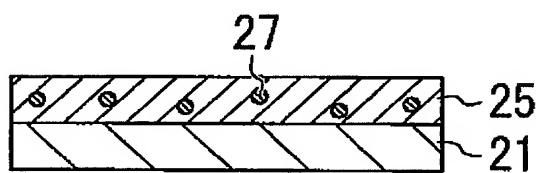
[Name of Document] Drawing

[Fig. 1]

(a)

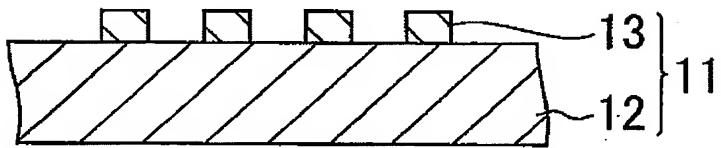


(b)

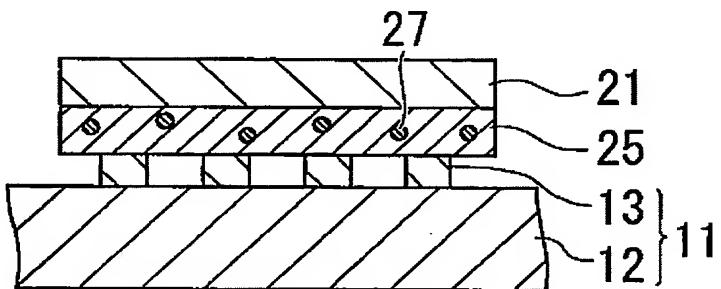


[Fig. 2]

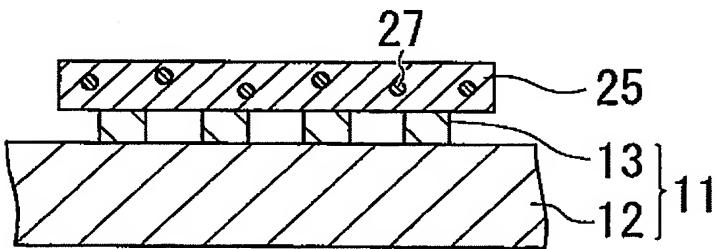
(a)



(b)

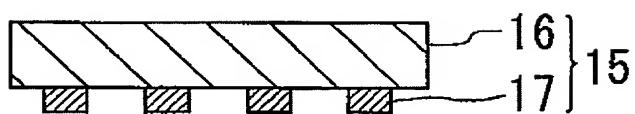


(c)

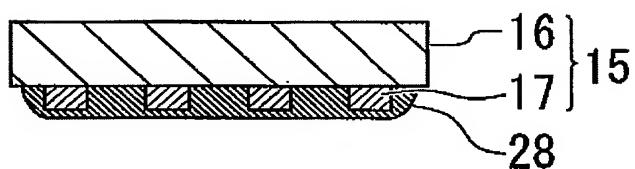


[Fig. 3]

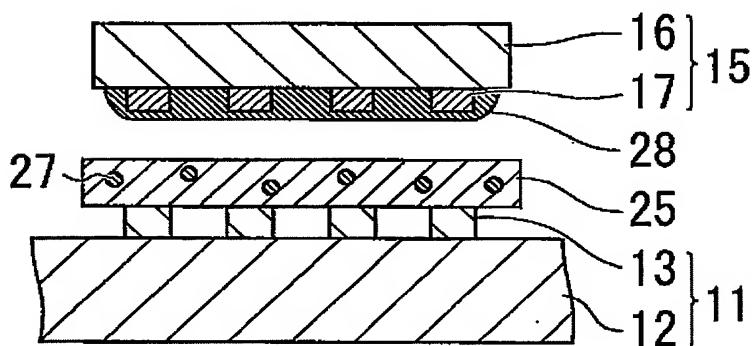
(a)



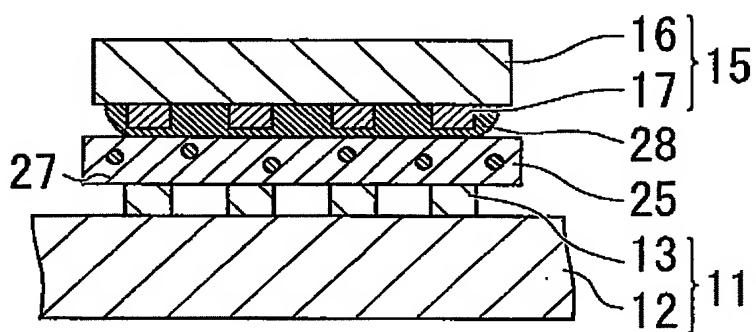
(b)



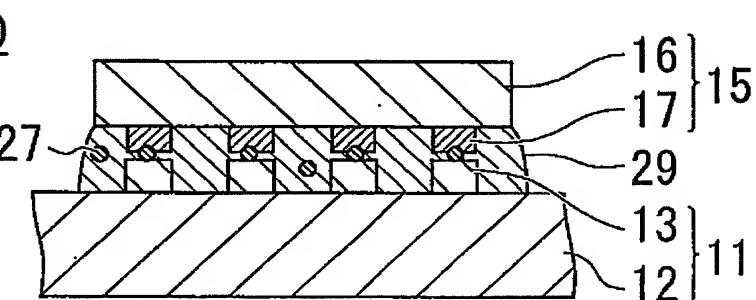
(c)



(d)

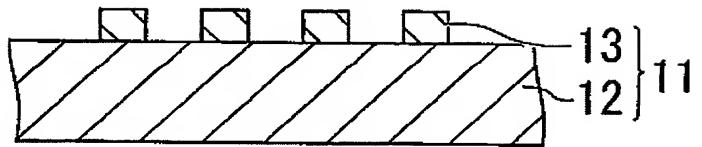


(e)

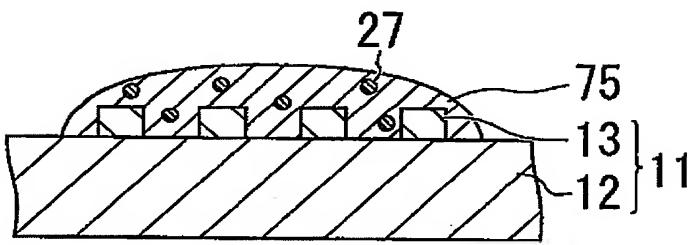


[Fig. 4]

(a)



(b)



(c)

